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ABSTRACT

This study compared the use of three instructional organizers--the advance organizer (AO), the participatory pictorial graphic organizer (PGO), and the final form pictorial graphic organizer (FGO)--in the design and use of computer-based interactive video (CBIV) programs. That is, it attempted to determine whether a less generative or more generative instructional organizer would most effectively facilitate learning and retention when used with this form of hypermedia. It was hypothesized that: (1) a PGO would be more effective in facilitating immediate recall than would either an AO or the equivalent FGO; (2) a PGO would be more effective in facilitating retention than the other two techniques; and (3) an FGO and an AO would not substantially differ from each other in their effect on immediate recall or retention. It was expected that the PGO would elicit a generative activity from the learner while the FGO and AO would depend on their nominal characteristics for any effect. The final study sample consisted of 61 university nursing students and faculty who were randomly assigned to three treatment groups. The CBIV program used presents two case studies in the nursing care of elderly patients with acute cardiac disorders using a structured discovery approach. They completed the first posttest (immediate recall) immediately after finishing the CBIV program and the second posttest (retention) one week later. Results did not support either of the first two hypotheses, and only partially supported the third; however, interview comments about the FGO emphasized its usefulness as an orientation tool; helpful as a guide to assessment and intervention decisions, and subjects in this group strongly outperformed the others on both posttests. A discussion of possible reasons for the unexpected results and suggestions for further research conclude this report. (41 references) (BBM)

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Introduction

In the current information age, society is continually being influenced and reshaped by rapid and pervasive changes in technology. Education has not been immune to these changes, although it has been slow to adapt (Braun, 1990, Dalton, 1989). In particular, the advent of the low priced and accessible microcomputer has placed the power and flexibility of computing into the hands of the individual. A major challenge for instructional designers is to learn how to make effective use of its capabilities to assist people to learn.

An exciting extension of the microcomputer revolution is the interactive computer-based learning system most commonly referred to as Computer-Based Interactive Video (CBIV), a hypermedia system which combines the power of the computer to support student interaction with the richness of the various audio and visual media. The main benefit of hypermedia (Kinzie & Berdel, 1990) is to facilitate learning by "making networks of related information available in a content-appropriate multimedia format (p.62)."

According to Jonassen (1984), the major advantage of CBIV is that it can be both adaptive and interactive. He defines adaptive as "the ability to adapt or adjust the presentation sequence, mode or sign type to meet a variety of instructional requirements..." and interactive to mean "that the program engages the learner to participate in a variety of ways that utilize learner responses..." (p.21).

Hannafin (1989) views interactivity as providing one or more instructional functions from simple procedural control to causing differentiated levels of cognitive processing. These functions of interaction include confirmation of response, learner control of pacing and lesson sequencing, inquiry (glossaries and libraries), navigation, and elaboration, techniques which allow learners to combine known with to-be-learned lesson information.

Learner Disorientation

CBIV, while providing such flexibility, is not without problems. One is the potential for learner disorientation, the loss of one's sense of location or of the structure of the material. Navigation is the most commonly identified user problem in hypermedia (Jonassen, 1989, Kinzie & Berdel, 1990, Rezabek & Ragan, 1989). Learners can easily become lost and frustrated and may give up without acquiring any information from the program.

Another problem is cognitive overload. Jonassen (1989) also notes that the exponentially greater number of learning options available to learners places increased cognitive demands upon learners that they are often unable to fulfil. Tripp and Roby (1990) claim that disorientation leads to the expenditure of more mental effort to maintain a sense of orientation in the program which in turn reduces the mental resources available for learning.

Instructional Design for Hypermedia

How might one then allay such disadvantages of hypermedia while capitalizing on its advantages? In a flexible environment such as hypermedia, self-regulation - skills for self-directed learning - is essential (Kinzie & Berdel, 1990). Systems can be designed to make the exercise of learner control and self-regulation successful and to enhance a learner's continuing motivation. Kinzie & Berdel (1990) suggest the use of such techniques as "motivating overviews" [original emphasis] that encourage users to explore different parts of the program and system maps to locate current position and to move to a desired location.

While Kinzie & Berdel (1990) emphasize self-regulation and motivation, Jonassen (1989) focuses on cognitive structure. In his view, effective browsers of hypermedia must be able to monitor their own comprehension of the information presented and to select appropriate strategies that facilitate integrating and synthesizing information. If the material can be organized to replicate content or expert knowledge structures, then it would better provide the needed anchors for re-structuring the learner's knowledge.

Jonassen (1989) suggests that designers of hypermedia should be concerned with two aspects: the information model presented by the program and the user interface. The former describes how to organize or structure the information. The user interface describes the tools that the user has for accessing and navigating through the system. These include indexes and menus, cross-referencing and hypermaps. A similar notion to system maps, hypermaps provide a graphical view of the program structure, allowing the user to select a node on the hypermap and be taken immediately to that part of the program. The theoretical advantage of using a hypermap (Jonassen, 1989) is that it should enhance the learner's structural knowledge (the knowledge of interrelationships between ideas) of the information in the program.

Instructional Organizers

One approach to enhance structural knowledge is the use of instructional organizers. Tripp & Roby (1990) suggest a traditional strategy, the advance organizer (Ausubel, 1960, 1963). Other related organizational approaches include the structured overview graphic organizer (Barron, 1969) and the pictorial graphic organizer (Hawk, McLeod & Jonassen, 1985), both derivatives of the advance organizer. The pictorial graphic organizer can be either participatory (providing spaces to be filled in by the learner) or final form (spaces already completed when given to the learner). Both structured overviews and pictorial graphic organizers resemble the hypermap and could potentially be used to assist navigation in a CBIV program. All three organizers are designed to relate the material-to-be-learned to the learner's existing cognitive structure to facilitate learning and retention.

Extensive research on the advance organizer has produced a conflicting evidence concerning its effectiveness in facilitating learning. Several reviews have been critical (Barnes & Clawson, 1975, Hartley & Davies, 1976, Macdonald-Ross, 1978, McEneany, 1990), while others have been supportive (Lawton & Wanska, 1977, Mayer, 1979a, 1979b, Luiten, Ames & Ackerson, 1980, Stone, 1984). Overall, advance organizers appear to have a modest effect upon learning and retention (Kenny, 1990). While noting far fewer research results, Kenny also found a modest effect upon learning and retention for structured overview and pictorial graphic organizers.

The few studies of organizers with CBIV-based instruction have mostly focused on the advance organizer. Carnes, Lindbeck & Griffin (1987) reported no significant differences for advance organizers with a computer-based physics tutorial. Krahn & Blanchaer (1986) found a statistically significant difference in favor of advance organizers in a computer-based medical simulation but assessed learning with a very small immediate recall test (six questions). Theory holds that an advance organizer is unlikely to assist immediate recall and should be expected to have its strongest effect on retention (Mayer, 1979a, 1979b). Research results have tended to support this assertion (Luiten, Ames & Ackerson, 1980, Stone, 1984, Kenny, 1990).

Tripp & Roby (1990) report the use of an advance organizer with a Japanese-English hypertext-based lexicon. Half the group using the advance organizer also received a visual metaphor. They speculated that

a statistically significant negative effect for the interaction between the two techniques may have negated any effect for the advance organizer.

Kenny, Grabowski, Middlemiss & Van-Neste-Kenny (1991) compared participatory pictorial graphic organizers to identical final form organizers when used with a commercial CBIV program on nursing elderly patients with pulmonary disease. The participatory graphic organizer group outperformed the final form group on a test of immediate recall. The difference was large (1.65 points on an 18-item multiple choice test) but was not statistically significant. However, the final form group obtained a slightly higher (0.18 points) mean score on the retention test (given after one week). As well, surprisingly, the final form group made a considerable gain (1.77 points) from the immediate recall test to the retention test. One would normally expect some forgetting to occur. This difference, however, was not statistically significant. Regardless, the result is consistent with advance organizer theory (Mayer, 1979a, 1979b) and may indicate that the final form graphic organizer affects learning in the same manner as an advance organizer.

Generative Learning

Pictorial and structured overview graphic organizers both appear to be most effective when presented in participatory form, that is, to be filled in or constructed by the learner (Kenny, 1990). Thus, Wittrock's (1974) generative learning hypothesis may provide a stronger basis for explaining the effectiveness of these techniques than does advance organizer theory. Wittrock claims that "it is the learner's interpretation of and processing of the stimuli, not their [the stimuli] nominal characteristics, which is primary" (p.88). In more simple terms, learners must construct their own meaning from teaching (Wittrock, 1985). Doctorow, Wittrock & Marks (1978) indicate that this involves not only generating meaning but overt activities as well; such as, generating associations among words, generating pictures, etc. By way of example, Wittrock (1990, p.347) expresses the view that even reading "involves generative cognitive processes that create meaning by building relations (a) among parts of the text and (b) between the text and what we know, believe and experience." That is, when we read, we generate meaning by relating parts of the text to one another and to our memories and knowledge.

Hypotheses

This study was intended to compare the use of three instructional organizers - the advance organizer (AO), the participatory pictorial graphic organizer (PGO) and the final form pictorial graphic organizer (FGO) - in the design and use of CBIV programs. That is, it attempted to answer the question of which form of instructional organizer (less generative or more generative) would most effectively facilitate learning and retention when used with this form of hypermedia. It was hypothesized that (1) a PGO would be more effective in facilitating immediate recall than would either an AO or the equivalent FGO, (2) a PGO would be more effective in facilitating retention than would the other two techniques and (3) an FGO and an AO would not substantially differ from each other in their effect on immediate recall or retention. A PGO requires the learner to fill in various blanks on the organizer and was considered to be a more generative technique than either its FGO version or an AO. To complete a PGO, the learner must select information from the CBIV program and write it in the appropriate place on the organizer. When using an FGO, the learner is asked only to read and remember the information presented by the organizer. Similarly, the AO presents information at a higher or more abstract level and is also meant to be read and remembered. Thus, it was expected that the PGO would elicit a generative activity from the learner while the FGO and AO would depend on their nominal characteristics for any effect.

Methods

Subjects

The study sample consisted of sixty-two university nursing students and faculty from a university College of Nursing in the northeastern United States. All subjects were female. This sample included three blocks or strata: third year (Juniors) undergraduates (n = 16), fourth year (Seniors) undergraduates (n = 19) and graduates (n = 27). The graduate block was comprised of twenty-one Master's degree students and six faculty members. The posttest data for one graduate, who was given the participatory graphic organizer treatment, was discarded because the subject had disregarded treatment instructions and took copious notes on both the front and back of the form. This left a total sample of sixty-one individuals.

Materials

An American Journal of Nursing CBIV program, The Nursing Care of Elderly Patients with Acute Cardiac Disorders was used in this study. This program presents two case studies each of which follow the progress of an elderly male patient from admission to hospital to discharge. One patient is admitted with a heart attack while the other is treated for congestive heart failure. The content of the program consists of specialized knowledge and skills in acute cardiac care such as the recognition of age-related changes in cardiac function, cardiac pathophysiology, knowledge of cardiac drugs and the reading of electrocardiogram (EKG) rhythms. The case studies consist of several video sequences of patient - nurse interactions, including decisions about how to treat the patient's condition and nursing responses to an emergency situation resulting from treatment.

The program uses a structured discovery approach in which the learner is presented with a video sequence followed by a decision point. At each point, the learner must make appropriate nursing assessment or intervention decisions in order to proceed. These decisions are rated on a scale ranging from +3 to -3. Those judged by the program harmful to the patient are scored -2 or -3 and result in immediate feedback accompanied by a request to try again. Appropriate or neutral decisions are accepted without immediate feedback. The learner cannot advance until sufficient appropriate decisions have been made. The prior video sequence is then replayed and accompanied by voice-over analysis by an experienced nurse.

Independent variables

The primary independent variables were the three instructional treatments: the PGO (considered the most generative), the FGO and an expository AO. The three organizers used in the study were developed by two subject matter experts (on adult medical-surgical and critical care nursing) and the author, whose expertise is in instructional design.

The graphic organizers were constructed according to Hawk, McLeod and Jonassen (1985). They were identical except that the FGO was completed while various blanks were left to complete in the PGO. They were designed to provide a combined chronological and comparison - contrast structure, that is, they followed the admission-to-hospital through treatment and discharge sequence of the program and provided side-by-side comparison of the stages for each case study.

The AO was constructed in expository form according to the prescriptions of Ausubel (1963, 1978) and Mayer (1979a). The content of the AO consisted of a discussion of clinical decision-making and the nursing process. This included an overview and a brief discussion of the five steps of the nursing process: assessment, diagnosis, planning, intervention and evaluation. The organizer also related the nursing process to collaborative problems which are solved in conjunction with medical personnel. All subjects would have studied this process in past and had varying degrees of familiarity with the material.

Dependent Variables

There were two dependent variables in this study: immediate recall and retention. Immediate recall was operationalized as a test of learning from the CBIV program given immediately after completion of the program and retention as a similar measure of learning given one week later. Both were measured by two, equivalent form, 24-question, multiple choice, posttests developed by the producers of the CBIV program. The posttests were criterion-referenced and nearly identical in format and question type. In most cases they differed only in terms of situational information such as patient assessment data. The test questions were developed on the basis of program objectives and follow nursing care scenarios resembling, but not identical to, the CBIV program itself (Rizzolo, personal communication). All questions tested nursing assessments and interventions for which the program was designed to provide practice.

Internal consistency reliability (Kuder-Richardson Formula 21) was 0.66 for Form A and 0.64 for Form B. The stability and equivalence reliability estimate was 0.59. Popham (1981) indicates that this yields the lowest estimate of test reliability since two factors - time delay and differences between the test forms - operate to reduce consistency of measurement. Estimates of 0.70 and lower may be considered acceptable for equivalence and stability.

Procedures

Subjects were randomly assigned to the three treatment groups - PGO, FGO or AO - by block (strata). All subjects were asked to read their organizer immediately prior to doing the CBIV program. The purpose of the organizer was explained at that time. Those in the PGO treatment group were also asked to

fill in the blanks in the organizer either during or immediately after the CBIV program. The subjects were given complete freedom to proceed through the program as they wished although they were requested to attempt both case studies. They were, however, asked not to take notes except where required by the PGO treatment. This was done to counteract note-taking as a possible confounding factor, a problem which occurred in the previous study (Kenny, Grabowski, Middlemiss & Van-Neste-Kenny, 1991).

Students completed the first posttest (immediate recall) immediately after finishing the CBIV program and the second (retention) posttest one week later. They did not have access to the program in between testings.

Experimental Design

This study used a three by three by two factorial design with one repeated measure, or a split plot factorial (SPF) design (Kirk, 1982). The design factors for this study were the three treatment groups, the three blocks (Junior, Senior, Graduate), and the order of presentation of form of posttest. All subjects were randomly assigned to either Form A or Form B of the posttest for the test of immediate recall and given the other form for the retention test. This counterbalancing was carried out in order to compensate for any bias which might have resulted from differences in the two versions of the test. The criterion-referenced posttests represented the repeated measures factor.

The hypotheses were analyzed using planned contrasts. This was accomplished in two steps. First, a 3x3x2 MANOVA with one repeated measure was conducted to provide a pooled Mean Square Error term for the calculation of the planned contrasts and to provide a test of any main effects for the blocking and counterbalancing factors and their interactions with the main treatment effect.

Second, examination of the hypotheses reveals that a test of all pairwise comparisons was required. Consequently, the use of Tukey HSD contrasts was appropriate and, in this situation, more sensitive than the use of Dunn's procedure. Therefore, all six hypotheses were tested using the Tukey HSD procedure at $\alpha \leq 0.10$ level.

Convention holds that alpha is generally set at ≤ 0.05 and the selection of the 0.10 level may be considered liberal. Cohen (1990), however, labels the former a "convenient reference point along the

possibility-probability continuum" (p.1311) and claims there is no ontological basis for the dichotomous, yes-no decision of prevailing practice. He calls for the use of "more tolerant" 80% confidence levels in social science research (p. 1310) and the reporting of one or more effect sizes as the primary product of research inquiry. The choice of $\alpha \leq 0.10$ represents a compromise between convention and Cohen's position which allows for increased power and yet provides a reasonably stringent test of statistical significance.

Cohen (1988, 1990) also recommends power analysis. The Stone (1984) study was the more recent of two advance organizer meta-analyses and more consistent with advance organizer theory. The average effect size of 0.66 for retention from this study represents an intermediate estimate for the effect of instructional organizers on retention (Kenny, 1990) and was used in this analysis. For E.S. = 0.66, n = 20 (for each treatment group) and $\alpha \leq 0.10$, power $(1-\beta)$ is 0.78 and β error is 0.22. Cohen (1988) recommends a minimum standard for $1-\beta$ of 0.80. Therefore, based on the Stone meta-analysis, this study is slightly underpowered.

Exploratory Data

In addition to the posttests used to measure learning, the subjects completed a one page Program Use Survey which provided a self report of their use of such program options as the replay feature, the library and the glossary. The time each subject spent on the program was also measured and correlated, using Pearson r product moment coefficients, with posttest scores. Finally, every third subject from each treatment group and block (n = 18) was asked to participate in a semi-structured interview with the author after completing the second posttest. These interviews were intended to elicit a more detailed reflection of the participants' use of the CBIV program and of the instructional organizers.

Results

Results for descriptive statistical data are displayed in Table 1 and for the MANOVA in Table 2. Hypothesis 1 held that the use of a PGO would result in a higher mean score on a measure of immediate recall (Posttest 1) than would the use of either an FGO or an AO. This hypothesis was not supported. The PGO treatment resulted in a lower mean score on the first posttest (18.05) than did the AO treatment (18.857).

The difference was not statistically significant [$|0.807| < q_{.90}$ (3, 120) = 1.77].

The PGO treatment also resulted in a substantially lower mean score on the first posttest (18.05) than did the FGO treatment (20.9). Further, the difference was statistically significant at the $p \leq 0.01$ level. [$|2.85| > q_{.99}$ (3, 60) = 2.622].

Table 1

Descriptive Statistics

		Posttest 1		Posttest 2	
	N	M	SD	M	SD
PGO	20	18.05	3.09	16.70	3.66
FGO	20	20.90	2.77	19.40	3.79
AO	21	18.86	2.99	18.52	3.30

Table 2

Repeated Measures Analysis of Variance
Tests of Hypotheses for Between Subjects Effects

Source	df	SS	MS	F	p
Treatment	2	94.08	47.04	4.21	0.022*
Order	1	30.33	30.33	2.71	0.107
Treatment*Order	2	19.56	9.78	0.87	0.424
Block	2	318.63	159.32	14.25	0.0001**
Treatment*Block	4	76.24	19.06	1.70	0.167
Order*Block	2	23.54	11.77	1.05	0.358
Treatment*Order *Block	4	36.00	9.00	0.80	0.529
Error	43	480.88	11.18		

* $p \leq .05$
** $p \leq .01$

Hypothesis 2 stated that the use of a PGO would result in a higher mean score on a measure of retention than would the use of either an AO or an FGO. Once again, the hypothesis was not supported as the PGO treatment resulted in a lower mean score on the second posttest (16.7) than did the AO treatment (18.52). The difference was statistically significant at the $p \leq 0.10$ level. [$|1.84| < q_{.90}$ (3, 60) = 1.790]. The PGO treatment also resulted in a substantially lower mean score on the second posttest (16.7) than did the FGO

treatment (19.4). This difference was statistically significant at the $p \leq 0.01$ level. [$|2.70| < q_{.99}$ (3, 60) = 2.622].

The third hypothesis asserted that the use of an FGO would result in no greater effect on immediate recall or retention than would the use of an AO. This hypothesis was not completely supported. The FGO treatment resulted in a considerably higher mean score on the first posttest (20.9) than did the AO treatment (18.857). This difference was statistically significant at the $p \leq 0.05$ level. [$|2.043| < q_{.95}$ (3, 86) = 2.0367]. However, while the FGO treatment also resulted in a higher mean score on the second posttest (19.4) than did the AO treatment (18.524), the difference was not statistically significant [$|0.877| < q_{.90}$ (3, 120) = 1.77].

Analysis of Exploratory Data

Crosstabulations of the comparison between treatments by survey subquestion displayed no patterns indicating a differential use of the CBIV program which might explain the difference in posttest means among treatments. Further, analysis of variance of the mean survey question scores showed no statistically significant difference between the three organizers.

Nor was there an apparent difference among the three treatment groups in the amount of time taken doing the program. Pearson r correlation coefficients are reported in Table 3. None were statistically significant.

Table 3

Pearson r Correlation: Time * Posttest Scores

Treatment	Time	r	p
AO	Immediate	-0.322	0.154
AO	Retention	-0.045	0.845
FGO	Immediate	0.187	0.431
FGO	Retention	-0.240	0.307
PGO	Immediate	-0.122	0.608
PGO	Retention	-0.153	0.520

Also, with the exception of the correlation between the FGO posttest 1 and time taken, the relationship was always negative. As well, more detailed analysis of the scatterplot for this relationship and of the Program Use Survey indicates an outlier representing an

individual who did not complete either case study. Elimination of her scores changes the correlation between time taken and the FGO posttest 1 scores to -0.153 and while the coefficient for posttest 2 drops to -0.27. It appears that those who took more time doing the program tended on average to score lower on the posttests.

Finally, analysis of the interview data revealed a number of trends. Perhaps the most striking trend was that the guided discovery approach, which required the learner to make nursing assessment and intervention choices and rated them on their decisions, tended to be distracting and disorienting for most subjects. Subjects had problems with the way these choices were rated, on the amount of information provided in response to these answers and the manner in which it was given.

The interview data also revealed that the study was able to provide conditions under which instructional organizers, particularly AO's might be expected to be effective. Most participants reported the lesson material to be unfamiliar and moderately difficult. The effect of the different organizers on the subjects' encoding process is less clear. Most found the AO treatment irrelevant. The FGO, on the other hand, was found to be a useful orientation tool by many study participants. It proved particularly helpful as a guide to assessment and intervention decisions. That the PGO treatment tended to influence encoding is less clear from interview responses. Some reported its usefulness while others found it an interference. Several had wished to alter its use to suit their own learning approach.

Finally, the question of whether or not the restriction on note-taking was a confounding factor is also unclear. Slightly more than half those interviewed indicated that they found this an interference while the others stated it was not a problem. Those who found the restriction an interference wanted the notes to allow them to review, either for future testing or for use of the information on the job. Those who did not indicated that they would not have taken notes regardless or that they were poor note-takers and did not tend to make good use of their notes.

Discussion

The first and second hypotheses predicted that learners receiving a PGO - operationalized as the more generative treatment in this study - would outperform, on average, those who received either an AO or the equivalent FGO on tests of both immediate recall and retention. Confirmation of these hypotheses would provide evidence that Wittrock's (1974) generative learning hypothesis could be applied to the use of instructional organizers with CBIV. However, analysis of the results indicated no significant effect in favor of the PGO treatment on the mean scores of either posttest. In fact, the PGO treatment group had the lowest mean score in every comparison. The results of this study, then, provide no evidence to support the application of the generative learning hypothesis as operationalized as a PGO. Unquestionably, the filled-in version of the same organizer was the most effective technique.

The third hypothesis predicted no difference between the FGO and AO treatments. While not expected, evidence in favor of the AO treatment might have provided support for advance organizer theory and for the effectiveness of this technique when used with CBIV. The AO fell somewhere in between the other two techniques. As predicted by theory (Mayer, 1979a, 1979b), the AO in this study was not effective in aiding immediate recall. However, neither was it the most effective in assisting retention. While significantly more effective than the PGO treatment, it was less effective (though not statistically significantly so) than the FGO in aiding retention.

These results raise two issues. First, why would the same organizer be much less effective when the learner had to seek answers in the CBIV program to complete it than when the information was provided? Second, why was the AO not more effective?

Exploratory quantitative analysis indicated no substantive differences between treatment groups which might answer these questions. There was no evidence of the differential use of the program features nor of any effect on time on task for any treatment group. As well, examination of the organizers revealed that extraneous note-taking, a problem in the previous study (Kenny, Grabowski, Middlemiss & Van-Neste-Kenny, 1991), was controlled in this experiment.

Was the generative activity truly generative?

The most likely explanation for the ineffectiveness of the PGO was that, as operationalized in this study, it did not constitute a generative activity. As in the previous study (Kenny, Grabowski, Middlemiss & Van-Neste-Kenny, 1991), completion of the PGO remained a problem. Twenty-five percent (five of twenty) of the PGO group left five or more blanks incomplete and ten percent left more than ten spaces incomplete. The PGO's were also scored to determine if they were being completed correctly. The average score was 21.6 of a possible 38, indicating that the subjects completing the PGO were having difficulty determining what went in the blanks. From these two studies, it appears that learners may need further assistance in using this technique, in the form of training, more clear categories on the organizer or some form of feedback in order to make use of this technique. Indeed, Hawk, McLeod & Jonassen (1985) do recommend that the instructor review the PGO periodically with the students and verify its correct completion at the end of the unit. This was not possible in this study and would have added a practice factor as an alternative explanation to the expected generative effect. However, it is feasible in CBIV to provide the PGO on screen (rather than on paper) and to have it corrected electronically.

The PGO may also have constituted an additional activity in an already generative situation and may have actually contributed to, rather than counteracting, cognitive overload. The interview data indicate that learners had considerable difficulty with the structured discovery approach. It is this aspect of the program design which appears to provide the strongest explanation of the superiority of the FGO. The learners were repeatedly faced with making nursing assessment and intervention decisions. They were unable to proceed unless their decisions were appropriate. To make the correct decisions, they needed information and some of this was contained in the blanks on the FGO (but left out to be filled in by the learner in the case of the PGO).

Interview comments about the FGO almost all focused on its usefulness in "getting through" the assessment and intervention segments. They saw it as a form of cheat sheet. The FGO, then, appears to have reduced learner confusion and disorientation by making it easier to proceed. It reduced cognitive overload by directly indicating some assessment and intervention choices and providing clues to others. The subjects in this group strongly outperformed those in the other

treatment groups on both posttests. Thus, it seems reasonable to suggest that the FGO may have allowed those subjects receiving this treatment to concentrate more fully on learning the material while the subjects in the other two groups had to expend more effort merely getting through the program.

The AO clearly did not contain the information needed to proceed through these segments. It was not meant to. Its purpose was to prepare the learner's cognitive structure to receive the information in the program and, thus, to aid retention. The PGO, would only have contained the needed information for the assessment and intervention decisions if the subjects in that group had been filling out the form correctly as they proceeded. This assumes that they were able to determine what went into the spaces provided before reaching assessment or intervention selection screens. It is likely that the participants were not able to do so. The details were provided after the assessment and intervention choices by means of a review of the sequence and analysis by an expert nurse. Like the AO treatment group, the only information that they had available was what they remembered.

The members of both the PGO and AO treatment groups were faced with confusion and, occasionally, frustration created by this specific program feature and their particular organizer appeared to be no help. To make matters worse, while those in the PGO group were coping with this difficult process, their organizer was asking them to carry out an additional task. It may have produced cognitive overload by asking the learners to expend more mental effort on this additional activity when they were already engaged in a difficult task. Consequently, it is doubtful that they were able to sufficiently focus on the PGO and to generate their own meaning from it. This may explain the relatively low scores (an average of 21.6 out of 38) on the organizer.

Was the advance organizer used according to theory?

The second issue pertained to the apparent ineffectiveness of the AO. While the AO in this study was more effective than the PGO, it was consistently less effective than the FGO. A frequent criticism of advance organizers is that it is not clear how to construct them (e.g. Barnes & Clawson, 1975, Hartley & Davies, 1976). This is disputed by Ausubel (1978) and Mayer (1979a) who stressed that these reviews were not sufficiently sensitive to theory. Thus, for example, an AO must be presented at a higher, more abstract

level and in advance of the material-to-be-learned. It can be expected to facilitate retention rather than immediate recall and to be effective only if the material-to-be-learned is difficult, unfamiliar to the learner or disorganized. Is it possible that the AO used in this study was constructed poorly or used in a instructional situation in which it could not be expected to facilitate learning?

The specifications of Ausubel (1963, 1978) and Mayer (1979a) were followed closely in constructing the AO used in this study. The organizer discussed two higher level (more abstract) topics, the nursing process and collaborative problem-solving. Both processes were carefully adhered to in the nursing care portrayed throughout the program and provided the basic sequence of each case study. In neither case study, however, were the nursing process nor collaborative problem-solving specifically discussed, that is, the organizer clearly is presented at a higher, more abstract level than the CBIV program material and contains no specific content (the actual cardiac material) from the CBIV program. It was presented before the subjects did the CBIV program.

As well, the subjects who participated in this study had neither been trained nor had worked in the cardiac specialty. The interview data confirmed that they were generally unfamiliar with the program material. They also rated the material as moderately difficult. Mayer (1979a) also stipulated that an AO, to be effective, must be capable of generating relationships in the material-to-be-learned and of influencing the learner's encoding process. The first point is answered in the construction of the various organizers. All have clear structures and were judged capable of generating such relationships.

The second point, while also a matter of judgment by the instructor or instructional designer, can only be truly decided after the fact. The analysis of the posttest mean scores appears to indicate that the PGO had little facilitating effect (and may have impeded encoding) while the FGO had the strongest influence. The effect of the AO, which fell somewhere in the middle of the two versions of the graphic organizer, is difficult to determine from this evidence. The interview responses, however, cast some doubt about whether it did. The AO taught (or reviewed) the theory of nursing process. Two graduate students in this treatment group noted that the organizer stimulated them to think about this process while doing the program. One junior failed to see the use of the AO but remembered its content as familiar which may indicate it had a subconscious effect. The rest saw no

connection between the program and organizer material. For them, any influence on encoding, therefore, would have had to be quite subtle.

In summary, perhaps the best explanation for the effectiveness of the FGO treatment stems from the structured discovery approach of the CBIV program design which appeared to cause considerable confusion and disorientation for the study's participants. The FGO contained specific information which may have allowed the subjects in that treatment group to more successfully navigate these sequences and to concentrate more fully on learning the content of the program. The AO and the yet-to-be-completed PGO did not contain such information and likely did not provide any assistance. The PGO may have even contributed to cognitive overload by presenting an extra demand upon the learners' mental resources at a time when they were already faced with a difficult task and effectively interfered with their learning rather than assisting it. These results demonstrate that instructional design choices about which such techniques to include with instruction provided by CBIV depend on context. Rather than depending on one most effective technique or instructional theory for all circumstances, instructional designers may have to take into account the specific design attributes of the program in question and choose accordingly.

Recommendations for Further Research

It was assumed for the purposes of this study that participatory pictorial graphic organizers (PGO) were a form of generative activity and would be more effective in assisting students to learn and retain information from a CBIV program than either its FGO version or an AO, forms which are dependent on their nominal characteristics for any effect on learning. This prediction was not supported by the results. The participatory form was the least effective. One explanation is that the PGO was not a generative activity as presumed. To test this hypothesis, further research could be conducted comparing the PGO to other instructional techniques demonstrated, or postulated, to be generative, such as pattern notes (Jonassen, 1984, Fields, 1982) and concept maps (Novak & Gowan, 1984).

Second, the results of this study supported the use of the FGO, at least with instruction presented in CBIV of a similar design to the Cardiac program. A further test of the effectiveness of this technique could be carried by comparing its use to that of

hypermaps (Jonassen, 1989) or to an epitome used in instruction developed on the basis of Elaboration Theory (Reigeluth and Stern, 1983) as suggested by Rezabek and Ragan (1989). Further, this contrast could be conducted with hypermedia of varying structure, such as a CBIV program developed using Elaboration Theory, one organized in modules like that used in this study or even a program featuring unstructured hypertext.

Jonassen (1989) also suggested that the less structured the hypertext is, the less likely are users to integrate what they have learned into their own knowledge structures. He proposed that if the material can be organized to replicate content or expert knowledge structures, then it would better provide the needed anchors for re-structuring the learner's knowledge. In fact, in this study, the AO and the PGO were advanced as possible methods to provide such anchors by reflecting the higher level content structure of the material-to-be-learned. The assumption was that learners might lose track of any such structure provided by the program when using various program options. However, in this study, the subjects followed the program structure quite carefully. The comparison of the use of the FGO to other techniques such as hypermaps in both structured and unstructured hypertext versions of the same material might shed further light on how these techniques facilitate learning.

Third, research on the use of diagrams in instruction (Winn & Holliday, 1982) has indicated the usefulness of including small pictures to teach concept identification. The graphic organizers in this study make use of a number of such pictures. For instance, a cartoon depiction of a heart with an injured area is used to indicate that one case study deals with a heart attack while a similar cartoon represents congestive heart failure. Similarly, a drawing of a stethoscope is used to indicate sections of the organizer pertaining to nursing assessments and a sketch of a magnifying glass to denote sections focusing on observations. What is the role of such pictures in the pictorial graphic organizer? Do they add something or does the organizer depend on its diagrammatic elements such as the placement of headings and boxes for its effect? One relatively simple study would involve the comparison of the use of the FGO with pictures to its equivalent form with the pictures removed.

Also, Wittrock and Alesandrini (1990) sought to determine how learners use their analytic processing ability (ability to abstract a common dimension across stimuli) and holistic processing ability (ability to construct a whole from information about its parts)

differently under varying conditions. In the previous study (Kenny, Grabowski, Middlemiss & Van Neste-Kenny, 1991), it was hypothesized that the graphic organizer would stimulate both analytic and holistic processing. While no relationship was found, the study also used a small sample size. The interaction of diagrammatic techniques such as the graphic organizer with individual ability and preference needs further investigation. For instance, as Jonassen (1989) stressed, techniques such as hypermaps depend on spatial skills that a learner may lack and should be used with caution. Is this true? What spatial skills are needed to effectively process a hypermap or a graphic organizer? How would a learner's holistic processing ability (ability to construct a whole from information about its parts) relate to these skills?

Finally, the note-taking requirement of the PGO raises the question of structured versus unstructured note-taking. Do some students take good notes and others not? Would students benefit from training in note-taking? Are structured note-taking techniques a generative activity or do they interfere with the learner's generation of meaning by being too constraining? There are clearly a number of research questions about note-taking suggested by this study which could be investigated. An obvious extension of this study would be the comparison of constraining learners to the structure provided (as was done with the PGO treatment) to allowing them to use the structure as a guide which they could modify as they see fit. And last, it would be informative to compare a structured note-taking format such as the PGO to other note-taking techniques such as pattern noting (Jonassen, 1984, Fields, 1982).

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